THE HAILSTORM OF APRIL 1938 AT WASHINGTON, D. C.

UNUSUAL FALL OF LARGE HAILSTONES AT WASHINGTON, D. C.

By GILES SLOCUM

[Weather Bureau, Washington, D. C., May 1938]

On April 29, 1938, Washington and its vicinity were visited by a destructive hailstorm. Damage was estimated at $100,000. At the Weather Bureau, two windows were broken, several automobile tops punctured, and leaves and twigs stripped off trees.

The storm approached the Weather Bureau office from the west at about 12:15 p. m., E. S. T., with rain beginning about 12:30 p. m. The rainfall soon became heavy and a few hailstones were seen mixed with the rain. Then larger stones, unaccompanied by noticeable rain, commenced to fall at about 12:36, with the wind becoming strong for a few seconds.

After the storm, some of the hailstones were picked up and in the majority of cases found to be roughly hemispherical at one end and conical at the other, the longest axis passing through the vertex of the cone—the shape for maximum streamlining. Figures 1 and 2 show some of the stones gathered after they had partially melted. In both photographs, the stones are shown approximately in natural size. The circle in the center of figure 2, for comparison, is the size of a pile of quarter dollars. The largest stones measured at the Weather Bureau were somewhat less than an inch and a half in their longest dimension, but some the size of baseballs, according to reports, fell in northeast and southeast sections of the city and at Bolling Field airport.

Falls of damaging hail in Washington are rare, and if the report of stones as large as baseballs in outlying portions of the city is authentic, this ranks among the heaviest hailstorms Washington has ever experienced.

THE FORMATION OF IRREGULARLY SHAPED HAILSTONES

By DAVID L. ARENBERG

[Blue Hill Observatory, Milton, Mass., August 1938]

On April 29, 1938, the city of Washington and its suburbs were treated to a display of hail that surpassed previous records in that locality. Not only because of the financial losses estimated at $100,000 to greenhouses, automobiles, crops, and buildings, but because of the unusual shape of the icy missiles, the occasion merits attention. As the storm occurred during the annual meeting of the Meteorological Section of the American Geophysical Union, meteorologists were not lacking to examine the effects.

There were two distinct periods of hail. Rain which began to pour from a thunderstorm that had built up in the northwest at 12:30 p. m., changed to hail at 12:32, to rain 2 minutes later, and back to hail at 12:36 which lasted until 12:54. In the first stage the stones were few and small, about an eighth of an inch across, displaying no concentric shells, and were irregularly shaped like kernels of corn.

The second period was more severe and caused all the destruction, with hailstones whitening the ground and piling up a few inches deep in gutters and depressions. A size of three-fourths inch was common and many hailstones were measured over an inch in length. The majority were triangular pyramids with distinct faces and dihedral angles of various sizes and spherical bases. Quadrilateral, pentagonal, and other polygonal forms were also frequent; so that, in general, the shape was that of kernels of corn, although much larger and with structural features additional to those of the first type. The shorter axis varied from about two-thirds to one-third that of the longer which was along the altitude of the pyramids. The outer layers were very rough, consisting of loose ice particles and crystals, and rime, that soon melted disclosing the hard interior. The interior consisted of three portions: One of hard, clear ice extending from the apex to about one-fourth the distance to the base; the second containing as many as 12 circular arcs of varying thickness of alternating clear and opaque ice easily visible to the naked eye for one-third the total length, with centers of curvature concentric at the apex; the third portion was of white ice of irregular formation of no definite structure and softer than the previous two.

The method of formation of such irregularly shaped hailstones has been variously explained. One of these is that, from an initial irregularity of the core, the development continued unsymmetrically; the flattened base being kept continually against the droplet bearing air currents, so that streamline flow determined the resultant shape of the added water as it froze. The hypothesis has various difficulties in the present case although it serves for less marked irregularities: (1) The apparently complete absence of any spherical stones would require a uniform condition of asymmetry at the start; (2) streamlining of a partly frozen nucleus into a teardrop design would be most apt to develop a circular or elliptical cross section rather than the polygonal one observed in the trailing apex; (3) the successive layers of clear ice built up around the hailstone would have to be complete, due to excess liquid flowing from face to rear—instead, the portions of arcs found were sharply truncated; and (4) the streamlines about an irregularly shaped object are very seldom circular or concentric with a point on the surface, in contradiction to the condition observed above.

Hann [1] in publishing some photographs of hailstones, which, with the exception that the number of layers were not so numerous, are very similar to those that fell in Washington, briefly remarks that they have the appearance of being formed by the explosion of balls of ice, and other observers believed collisions in the upper air may have shattered the stones, but no further details are given.

The following preliminary computations indicate that the above process is within the realm of possibility.

The rate of heat loss may first be determined from the formula for the steady state conduction of a sphere of radius R_2 with surface temperature fixed at T_2, and whose temperature at a distance R_1 from the center is maintained at T_1.

$$dH=4\pi k\frac{(T_1-T_2)}{R_2-R_1}R_1R_2dt \tag{1}$$

This loss will freeze completely a layer of the nucleus PLM grams where P is the percentage of the liquid nucleus by weight that is frozen, L the latent heat of fusion, M the total mass may be determined from the volume of the shell $4\pi R_1^2$ in area and dR_1 thick.

$$4\pi k(T_1-T_2)\frac{R_1R_2}{R_1-R_2}dt=PLM, \qquad M=4\pi R_1^2dR_1 \tag{2}$$

$$t=\frac{PL}{k(T_1-T_2)R_2}\int(R_2-R_1)R_1dR_1 \tag{3}$$

[1] Hann-Süring: Lehrbuch der Meteorologie, 4 Ed. Leipzig, 1926, p. 720.

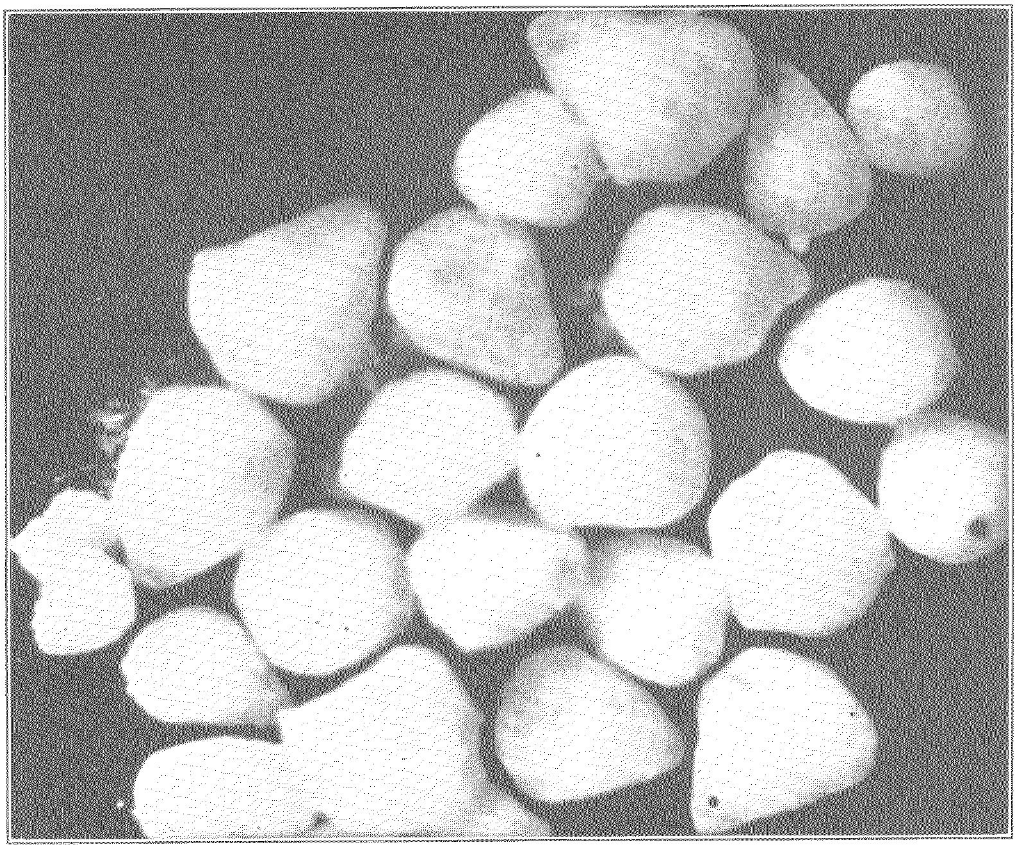

FIGURE 1.—Hailstones (actual size) at Washington, D. C., April 29, 1938.

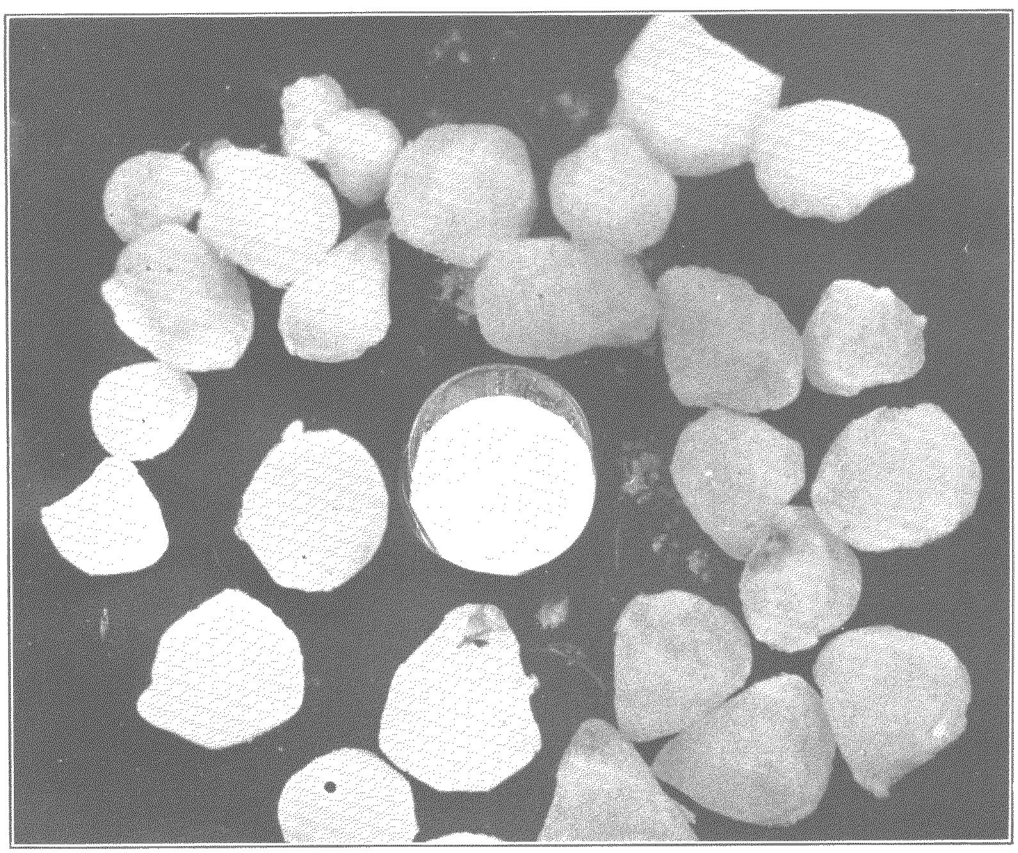

FIGURE 2.—Hailstones (actual size) at Washington, D. C., April 29, 1938. For comparison of relative size, note the pile of quarter dollars.